A 5-Gigacycle Tunnel Diode Oscillator with 9-Milliwatt Output from a Single Diode

By M. V. SCHNEIDER

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This brief paper describes a tunnel diode oscillator which has been built by using a single diode in a low-impedance strip transmission line.

Tunnel diodes were made from p-type zinc-doped gallium arsenide with a doping level of 7×10^{19} carriers per cubic centimeter. Peak currents in the range of 150–300 ma are obtained by alloying tin pellets with a diameter of approximately 1 mil to the gallium arsenide wafer.

A new type of mount has been used in order to reduce the package reactance as well as the contact resistance of the diode in the transmission

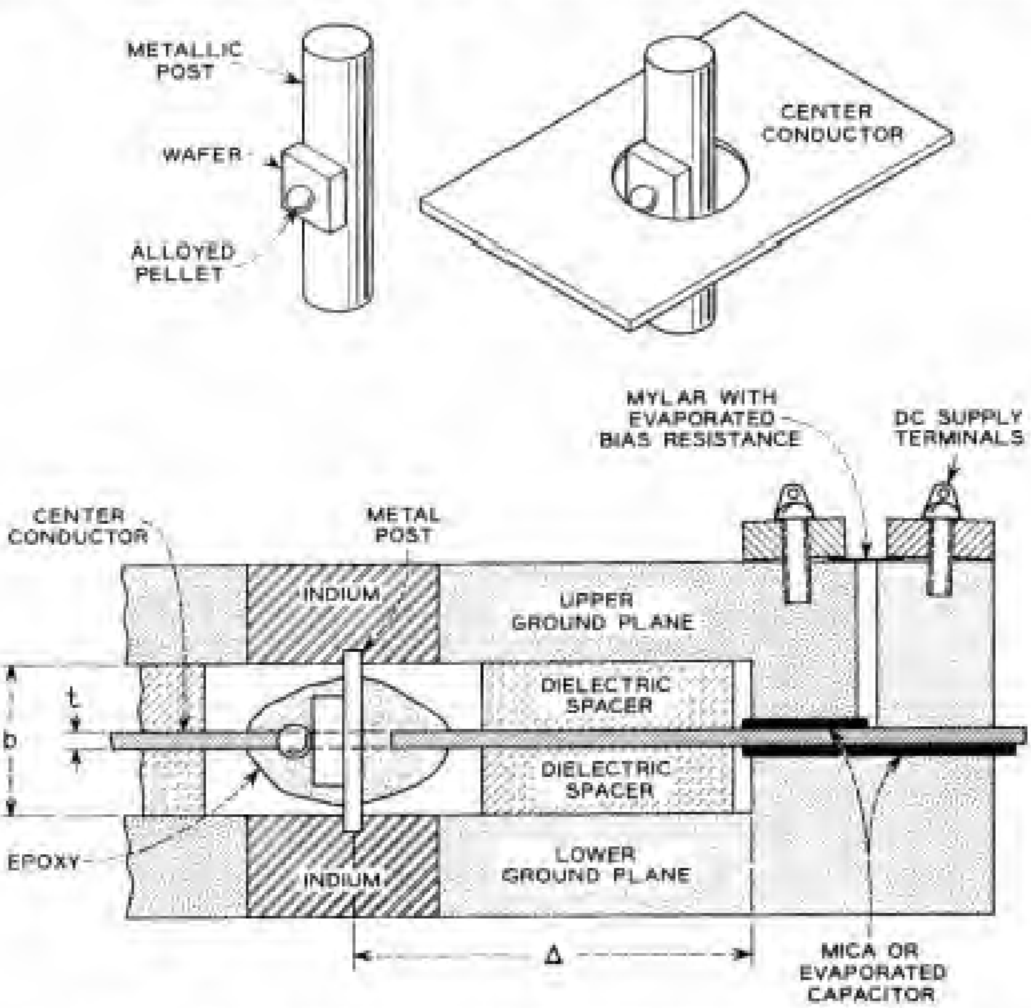

Fig. 1 — Tunnel diode mounted in balanced strip transmission line.

TABLE I — DIMENSIONS OF BALANCED STRIP TRANSMISSION LINE

Ground plane spacing	b = 6 mils
Width of center conductor	w = 100 mils
Thickness of center conductor	t = 1 mil
Distance diode to RF short	Δ = 100 mils
Impedance of strip transmission line	Z = 2.8 ohms

line. The mount is shown in Fig. 1. A hole with an 8-mil diameter is made in the 1-mil center conductor of the strip transmission line. The gallium arsenide wafer is alloyed to a 3-mil gold wire containing 3 per cent zinc. The diode is inserted into the hole, and the pellet is soldered

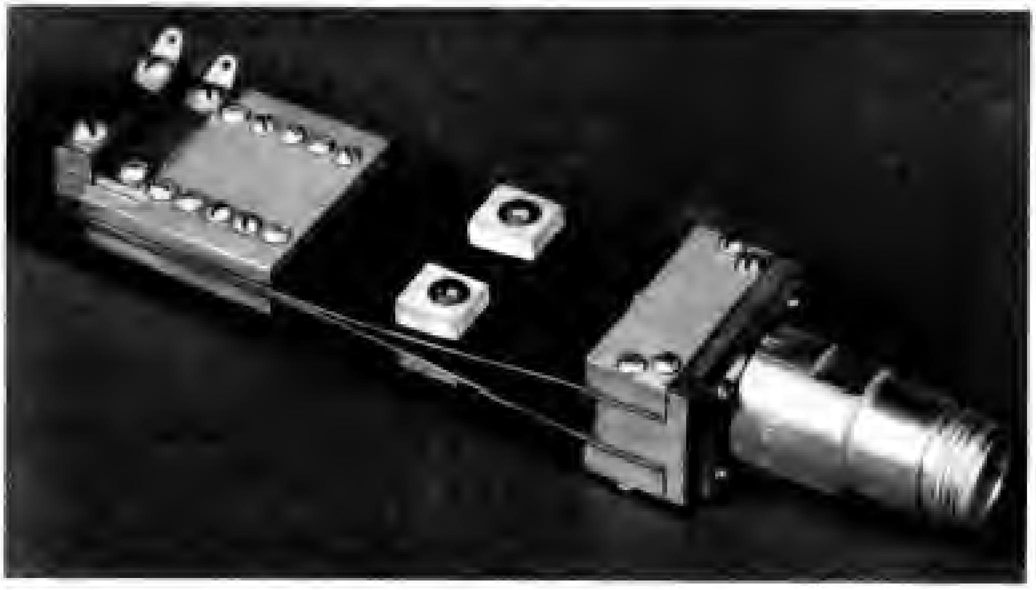

Fig. 2 — Complete tunnel diode oscillator.

to the tinned edge of the center conductor. A small drop of epoxy is used to lock the diode into the hole. The gold wire connects the upper and lower parts of the ground plane after the line is assembled.

It is advisable to have a radio-frequency short close to the diode in order to prevent the oscillator from multimoding. The distance between the diode and the RF short determines the frequency of oscillation. The short shown in Fig. 1 consists of a symmetrical step in the ground plane. The center conductor is insulated from the ground planes by an evaporated oxide film or a thin sheet of mica. This section serves at the same time as a bypass capacitor for the dc supply. The bias resistance consists of a thin nichrome film evaporated on Mylar.

The dimensions of a particular assembly are given in Table I.

A special line transformer is used for matching the low-impedance

TABLE II—ELECTRICAL PARAMETERS OF GALLIUM ARSENIDE TUNNEL DIODE

Peak current	I_p = 210 ma
Valley current	I_v = 12 ma
Peak voltage	E_p = 225 mv
Valley voltage	E_v = 560 mv
Junction capacitance	C = 12 pf

structure into a 50-ohm coaxial line. The impedance transformation is obtained by increasing the ground plane spacing b from 6 mils to approximately 300 mils. This type of transformation leads to a structure with relatively low losses. A broadband launcher is used for the transistion from balanced strip transmission line to coaxial line.

The complete oscillator is shown in Fig. 2. An output power of 9.1 mw at 4.85 gc was obtained from a single diode. The electrical parameters of the diode are listed in Table II.

The junction capacitance has been measured in the valley by using the techniques developed by D. E. Thomas.[1] Several attempts were made in order to determine the series resistance of high-current diodes in a transmission line with the dimensions given in Table I. It was found that the DeLoach method[2] gives very satisfactory results for relatively large ground plane spacings (10 mils and above); however, measurements at smaller ground plane spacings are at the present time not possible because of increasing line losses and because of launching problems.

Several oscillators were built with diodes having peak currents in the range from 150 ma to 250 ma. The output power ranged from 6 mw to 10 mw and the frequency of oscillation from 3.5 gc to 5.5 gc. No degradation effects have been observed. One particular oscillator has been running continuously for two months with a power stability of better than ±2 per cent, measured with a temperature stabilized power meter.

The author expresses his thanks to R. Neeld, who has developed the necessary techniques for assembling and mounting devices with an over-all size of several mils.

REFERENCES

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